Essays in Education

Volume 24 Article 3

Summer 8-1-2008

Development and Current Status of Science Education Research in Turkey

Mustafa Sozbilir
Ataturk University

Hulya Kutu
Ataturk University

Development and Current Status of Science Education Research in Turkey

Mustafa Sozbilir
Hulya Kutu
Atatürk University

Abstract

The aim of this study is to determine the status and the trends of subject matters investigated, research methods/design and data analyses procedures used in science education research papers published in Turkey. Data were obtained from 413 papers concerning science education from 28 different journals publishing educational research in Turkey. Each paper was subjected to a content analysis in terms of the subject studied, the research design/method and data analysis methods used according to the *Paper Classification Form (PCF)* developed by the first author. This document analysis has showed that although the science education research is a new research enterprise for Turkey starting in 1990s, it took great attention from the educational researchers and the number of papers published reached a peak around 2005 but then showed a decline in 2006 and 2007. Although there are great similarities with the international trends, there are differences as well in terms of the frequently studied subjects and research methods. Studying identifications of misconceptions are loosing the attention while teaching studies increases. On the other hand quantitative research methods are still dominating Turkish science education research while qualitative and mixed method researches are taking increasing attention in the world.

Introduction

Development of Science Education in the World

Science education has little history (Keeves, 1998) compared to the history of science, as a human endeavor and enterprise to explain the physical universe, it could go back to the beginning of human kind. While some studies were undertaken during the beginning of twentieth century, such studies commonly failed to acknowledge the universality of science education. The United Kingdom and United States were among the first nations to treat science education and research in science education in particular as a serious field of scholarship long before other nations. For instance, "The National Association for Research in Science Teaching (NARST)" in USA was founded in 1928 (Treagust, 2004) and "Association for Science Education (ASE)" in UK was established in 1963. In fact, the first British association bringing science teachers together was founded in 1901 and was called "The Association of Public School Science Masters (APSSM)" which was named as "The Science Masters' Association (SMA)" in 1918 until ASE was established in 1963 (Jenkins, 2001). In addition, first journals publishing researches in science education also come from USA and UK. *SSM* (School Science & Mathematic) and *SE* (Science Education), the American journals, started in 1901 and 1916 respectively and were followed by *SSR* (School Science Review), the British counterpart of *SSM* started its life in 1921.

Although the history of science education can be traced back to nineteenth century (Keeves, 1998) it was only the second half of the twentieth century that marked the

significant movement started with the Cold War era, in 1957, when the former Soviet Union launched the first satellite (the 'Sputnik"), into an orbit around the world. This evoked a shock around the world, and showed the relative inferiority in science and technology in several other big industrialized countries, especially the USA. Educational experts pointed out that one of the main causes of the deficit was the relative low quality of the existing science curricula (De Jong, 2007). In fact, there were unprecedented changes and expansion in school science education as a whole in the 1950s in order to recover from the demolition, the Second World War caused, especially in UK. The demands for scientists and technologist in the post-war years brought about a rapid expansion of the output of scientists from universities. To sustain the flow of university entrants it was necessary to give attention to science teaching in secondary schools (Harlen and Simon, 2001). All these effects made policy makers more willing to insert money into the developments of new curriculum. Finally, large-scale curriculum development projects were started in USA such as CHEM Study (Chemical Education Material Study), Physical Sciences Study Committee (PSSC), Biological Sciences Curriculum Study (BSCS), CBA (Chemical Bond Approach) and Nuffield Chemistry in UK. These leading projects adopted scientific knowledge as the primary goal and focused on understanding basic concepts and processes instead of knowing a large number of facts (Wallace and Louden, 1998). The new curricula also focused on stimulating the development of basic scientific skills, and classrooms were adapted or added for conducting laboratory work by students (De Jong, 2007). Although the expectations of the effects of the innovations were high, in general, the results were quite disappointing. The prevailing view was that these science curriculum reforms were unsuccessful because the intentions of the curriculum developers were not reflected in the teachers' actions (Wallace and Louden, 1998).

Many other countries followed the lead of USA and UK in adopting big-budget, discipline-knowledge based curriculum movement. Turkey was among those countries that translated American curriculum into Turkish, but this curriculum implementation was not successful throughout the country. In fact, the Ministry of National Education of Turkey (MEB) and the Turkish Scientific and Technological Research Council (TUBITAK) made a great effort to adapt the new science curricula, such as opening a science lab classroom for every secondary school (Türkmen, 1997). A discussion about the reasons why this curriculum implementation was unsuccessful could be found in Ayas, Çepni & Akdeniz (1993) and Türkmen (1997).

Because of the disappointments of the 1960s reform a second wave of curriculum innovations were initiated such as USA project of 'Chemistry in the Community' (ChemCom), and the British Salters' Chemistry project. In the 1980s reform, the projects were smaller and the design of most courses was much more focusing on 'active learning' of students. Moreover, as De Jong (2007) argues efforts were made to make science much more meaningful to students by relating science concepts and processes to situations from everyday life. Despite all these efforts, the results of this wave of curriculum reform were also quite disappointing. For instance, the enrolment in first-year university science was decreasing (Rocard *et al.*, 2007), and many secondary school students did not see the relevance of the given contexts for understanding the related concepts and rules. In order to solve the reported difficulties, about 5-10 years ago, a third wave of innovative science education projects came up. Some examples are the North-American project of 'Chemistry in Contexts: Applying Chemistry to Society' (CiC), German project 'Chimie in Konteks' (ChiK), 'Industrial Chemistry' (IC) in Israel, and the Dutch project of 'New Chemistry'. At this time, it is too early to evaluate the value of the recent reform properly. It is also important to recognize that

the interest in computer-assisted instruction and learning came up between the second and third wave of reform, followed by the growing use of internet in science education.

Research in Science Education

Research in science education is a relatively new enterprise. As Jenkins (2001) argues there are many examples of research undertaken in the first half of the twentieth century that can be categorized as science education, but much of it has been the work of individuals or quasi-government committees (p.17). Development of research in science education is strongly effected by the curriculum development projects. Therefore, research studies carried out during 1960s were often linked to curriculum development work which sought to explore the advantages of a new curriculum, or parts thereof, over an existing or previous one (Kempa, 1991). Many other studies were focused on difficulties in teaching new curriculum issues and the use of new teaching strategies. However, in the 1980s reform, new perspectives on teaching and learning caused a shift in the interest of many researchers towards studies of students' alternative conceptions and ways of reasoning (De Jong, 2007). The science education literature has been dominated by research findings concerned with children's understanding and learning of scientific phenomena in the last couple of decades (Jenkins, 2001). In line with this interest, more and more studies focused on students' learning process in terms of conceptual change. There was also a growing interest in studies of social and cultural dimensions of knowledge acquirement, for instance, by investigating the discourses between teachers and students in the classroom. Other trends were the growing interest in studies of laboratory work, especially (open-) inquiry, the implementation and use of problem solving strategies, and the use of internet, computer software, and interactive multimedia (De Jong, 2007).

Science Education Research in Turkey

Turkey, with a population of just over 70 million, is a bridge between Europe and Asia. The country was established in 1923, after the Ottoman Empire collapsed at the end of the 1st World War. The schooling consists of three main components: basic education (primary and middle schools, age 6–14; 8 years), which is compulsory; secondary education (lycees or senior high schools, age 14–18, 4 years); and higher education (colleges and universities). The Turkish Educational System was centralized by the Act of "Law of Unification of Instruction" in 1924. All schools throughout the country must use the same curricula, which are developed and implemented by the MEB (Ayas, et al, 1993).

Regarding teacher training, as stated by Türkmen (2007), Turkey has almost 135 years of elementary school teacher preparation history and experience from past to present as a formal and specially designed elementary teacher schools, institutes or colleges (faculties). Teachers, students, parents and all participants of education have complained about the science education in Turkey since 1924. A lot of science education programs were developed and applied by the MEB. All programs have been tried to be applied with a great excitement, but, unfortunately, science education problem has not been solved completely (Özden, 2007).

Starting with the 1990s Turkey focused on a nationwide restructuring on the education system. In 1990, the National Education Development Project (NEDP) was developed as another step toward improving the quality of teacher education in Turkey. It was implemented under the loan agreement concluded between the Turkish Government and the World Bank. NEDP, funded by the World Bank and administered by the Higher

Education Council (YÖK) and the British Council provided technical assistance (Güven, 2007; Tercanlıoğlu, 2004). The objective was to contribute to the improvement of pre-service teacher education. The focus of the project was curriculum development and materials production, the development of student-teacher experience in schools, establishment of a system of faculty-school partnerships, development of a set of standards in teacher education. It was also assisted with the provision of long-term and short-term fellowships and in upgrading the facilities of all schools of teacher education. The development of this project in Turkey has built on considerable change and development in teacher education in recent years. As a result of NEDP, programs of schools of teacher education (the name of courses and academic structures of teacher training colleges) and curricula (the content of courses) have become unique in the nation wide in 1998 (Türkmen, 2007). In 2003–2004, four years after the end of the project and the restructuring, a major study of their effects was conducted under the sponsorship of the Fulbright Commission for Educational Exchange between the United States and Turkey (Grossman, Onkol & Sands, 2006). Some restructuring has been made in the programs following the review in 2006.

On the other hand, the primary school curricula were renewed by the MEB in 2004. The new science curriculum was based on the philosophy of constructivism and active learning. This reform movement starting in 1990s increased interest in science education research. The first national biannual conference on science and mathematics education has been organized in 1994. This conference received little attention compared with the last one (8th National Science and Mathematics Education Conference) held in august 2008. In addition, Turkey is hosting several international conferences (few to be named; 18th ICCE (International Conference on Chemical Education) in 2004, 9th ECRICE (European Conference on Research in Chemical Education), 13th IOSTE (International Organization for Science and Technology Education) in 2008. All these conferences took enormous attention from the Turkish science education research community together with foreign researchers indicating the establishment of research in science education as a discipline. Several journals (mainly education faculties' journals) publish science education research papers with the exception of 'Journal of Turkish Science Education (TUSED)', an electronic peer reviewed journal since 2004 publishing only researches in science education. Although the research in science education is quite a new research area, it is difficult not to be impressed by the wide range of topics that Turkish researchers have chosen to investigate in the last ten years and the number of publication started to appear both inside and outside Turkey.

As the volume of published educational research increases, so the number of reviews increases in order to help researchers following the developments in different fields of educational research. Contents analyses are carried out in terms of the subject matters studied, the research methods employed, and the data analyses processes commonly used (e.g., Elmore & Woehlke, 1988, 1998; Hsu, 2005; Keselman *et al*., 1998). Identification of data-analytic practice may provide researchers a basis for recommending improvements in research and also a guide for the types of inferential procedures that should be taught in methodological courses so that students have adequate skills to interpret the published literature of a discipline and carry out their own projects (Keselman *et al*., 1998).

Few research review papers (e.g., Eybe & Schmidt, 2001; Rennie, 1998; Tsai & Wen, 2005) which systematically examine the research papers published in science education have appeared in recent years. Rennie (1998) surveyed research articles of five English-language science education journals *JRST* (*Journal of Research in Science Teaching), IJSE (International Journal of Science Education), RISE (Research in Science Education), RSTE*

(Research in Science and Technological Education), and SE (Science Education) published in 1996 to illustrate the quality of quantitative research articles. Rennie discussed problems associated with the use of statistically significant testing and made several recommendations such as how to improve the research quality of related papers, including the use of correct terminology, the providing sufficient information about the data to enable replications to be made, and the reporting and interpretation of effect magnitudes.

Eybe and Schmidt (2001) examined research papers in chemistry education specifically, based upon the quality criteria of publication from academic journals, reports, and documents. 81 chemical education studies from 1991 to 1997 published in the *IJSE* and the *JRST* were selected. The review was performed in terms of six quality categories and corresponding criteria: theory relatedness, quality of the research question, methods, presentation and interpretation of results, implications for practice, and competence in chemistry. These reports have given specific guidance for science education researchers on how to conduct research and to publish quality articles.

Most recently, Tsai & Wen (2005) conducted a content analysis in terms of the authors' nationality, research types and topics of total of 802 articles published by *IJSE*, *SE*, and *JRST* from 1998 to 2002. Given the results that majority of the articles are published by the authors from the English speaking countries, there were a significant number of papers published by the authors from non-English speaking countries indicating that science education research may have progressively become an important field recognized by the international academic community. The findings of the content analyses also showed that most of the published articles were categorized as empirical studies, while position, theoretical and review papers were rarely presented in the journals. The authors argued that although the research topic of students' conceptions and conceptual change was the most frequently investigated one in these five years, a declining trend was observed when analyzed by year. Moreover, in 1998–2002, the research topics related to student learning contexts, and social, cultural and gender issues also received relatively more attention among science educators.

Regarding Turkey there is no systematic study carried out in order to assess the development of science education research. The review carried out by Sozbilir & Canpolat (2006) is the only exception. In this study the developments in the world in educational research after the Second World War were reviewed and the paradigmatic changes in educational research methods and their effects on teaching science were emphasized. They also performed a small content analysis of the science education research published in Turkey and compared it with the international research compiled by Duit (2006) as a bibliography. The study showed that the history of science education research in Turkey hardly ever goes beyond the beginning of 1990s. However, the number of research shows a sharp increase after 1997 with the re-structuring of the educational faculties. The authors argue that Turkish science education community is facing challenging issues such as methodological deficiencies and following the trends in the world to overcome. However, a more comprehensive content analysis of publications may be helpful in revealing the recent trends of science education research in Turkey.

Purpose and the Research Questions

This study is aimed at determining the status and the trends of subject matters investigated and research methods/design and data analyses procedures used in science

education research papers published in Turkey. Specifically, this study was designed to address the following research questions:

- What are the frequently investigated subject matters in science education research published in Turkey?
- What are the frequently used research methods/designs in science education research published in Turkey?
- What are the frequently used data collection tools in science education research published in Turkey?
- What are the frequently used samples and sample sizes in science education research published in Turkey?
- What are the frequently used data analyses methods in science education research published in Turkey?

Results of this study should be of concern not just to the editors of the journals publishing science education research in Turkey and the practitioners of educational research, but also to the instructors of research methodology as well. This study is almost first in its kind in Turkey. It would be beneficial for both policy makers and the researchers. Especially the new researchers who are both consumers of the research publications and/or the conductors of quality research would benefit in selecting the subject matters to study and also designing their research methods and data analyses procedures.

Methodology

Data Source

Data for the present study were obtained from 413 papers concerning science education from 28 different educational research journals in Turkey. The list of the journals, the covered years and the number of papers selected each journal are given in Appendix 1. Most of the earlier issues of the journals are not available either on the web or as hard copy in many university libraries. Therefore, this study had to take the convenience sampling technique. The papers selected for analyses are found either from available hard copies of the journals issues in various libraries or electronic copies published on the web. Some of the journals are published only electronically. As it is almost impossible to reach all of the papers published so far, the sample selected is assumed as representing the majority of the papers published in science education area in Turkey. As seen from Appendix 1, most of the journal issues reviewed are published after year 2000. Only few journals published science education research before the year 2000.

Data Collection Instruments

*Each paper selected for analysis is subjected to content analysis by using the "*Paper Classification Form (PCF)*" developed by the first author. PCF is given in Appendix 2. The form composed of five components.*

The first part of the form is concerned with the subject matters studied. Each paper is categorized into one or more than one of the following eleven categories: (1) Misconceptions; (2) Teaching; (3) Teacher training; (4) Curriculum studies; (5) Development of tests/scales or translation/adaptation of the test/scales from another language to Turkish; (6) Attitudes; (7) Concept analyses; (8) Development of teaching materials; (9) Nature of Science; (10) Development of new research methods; and (11) Others. This classification was developed

by the first author in the light of the experiences gained in a previous small scale study (Sozbilir & Canpolat, 2006). In some cases one paper had to be categorized into more than one category as it contained two or sometimes three different research topics. For instance, it was common to investigate both of the effect of a particular teaching approach on any science topic and also its effect on students' attitudes towards science. Those papers get into both category (2) and (6) at the same time.

Regarding the research design/methods, each paper was categorized as quantitative, qualitative or mixed in nature. The papers were then categorized according to one of 22 research methods given in PCF. Development of this categorization is based on the classification described by McMillan & Schumacher (2006). The data collection tools are given under seven main groups: (1) Observations; (2) Interviews; (3) Achievement tests; (4) Questionnaires; (5) Documents; (6) Alternative assessment groups; and (7) Others. The samples used in the researcher are also divided into six titles as: (1) Primary (grades 1-5); (2) Primary (grades 6-8); (3) Secondary; (4) Undergraduate; (5) Graduate; and (6) Others. The samples sized were also noted.

Finally, PCF contained a section for data analyses methods. The data analysis is considered under three broad headings as descriptive, inferential and qualitative. Each of them had different techniques as listed in PCF.

Data Analysis

During the classification of papers, initially researchers and the graduate students (four MSc students) worked together. Ten papers selected randomly were classified together in the leadership of the first author. Then each graduate student worked independently on another ten randomly selected papers. Their classification was examined as a group and the disagreements were solved by discussion in order to increase the reliability. In the main study, the papers were categorized into the groups such as general science education, biology education, chemistry education and physics education. Then each graduate student worked on one group of the papers. Their classifications are checked by the authors. Both authors consulted each other about where there were some questions about the classification. The results of the classifications are analyzed by using SPSS and Microsoft Excel.

Findings

This section describes the results found in tables, charts and graphs. Most of the results are presented as charts and graphs as it appears to illuminating results better. Findings for each research question will be presented in order.

Frequently Investigated Subject Matters in Science Education Research

Science education research is a rather new research area in Turkey. As seen from Table 1 and Figure 1, although the history of science education research goes back to end of 1980s, it only starts to accelerate from the end of 1990s. This increase comes along with the re-structuring of education faculties in 1997 and still continues although the increase trend reaches a peak at year 2005. It appears that there is a decreasing trend starting with 2006.

Table 1. The total number of papers surveyed across the years (1987-2008)

Years	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	Total
f	1	2	-	2	-	3	6	1	4	3	2	7	22	20	28	34	50	56	75	50	37	10	**413**

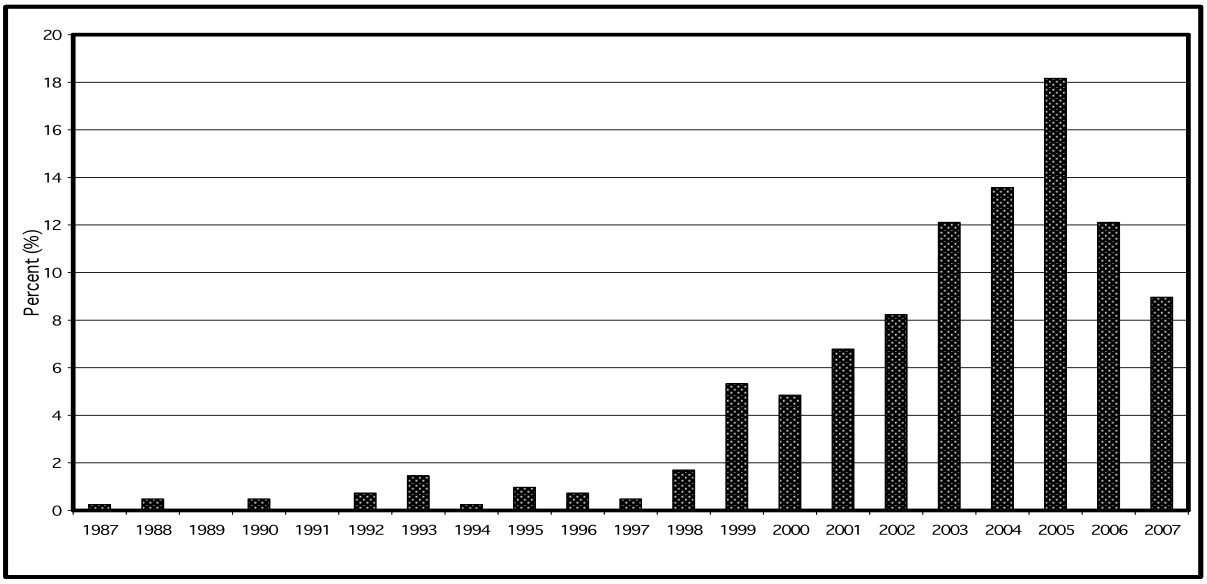

Figure 1. Distribution of the science education research papers surveyed across the years.

Regarding the subject matters frequently investigated Figure 2 shows that the studies focusing on teaching science concepts (28%), papers categorized as concept analysis (19%), attitudes towards science (17%) and identification of misconceptions (12%) are amongst the most common studies. There were also studies identified at less than 5% that of focusing on teacher training, curriculum, development of teaching materials, and development of test to measure academic achievement in various scientific concepts or adaptation of tests developed in different countries. This group of studies also included development, translation and adaptation of scales into Turkish to measure attitude, aptitude, skills etc. Figure 2 also shows that studies focusing on nature of science and discussion and application of new research methods in science education research are quite few. About 5% of the studies which are categorized as others include studies about use of ICT, environmental education etc.

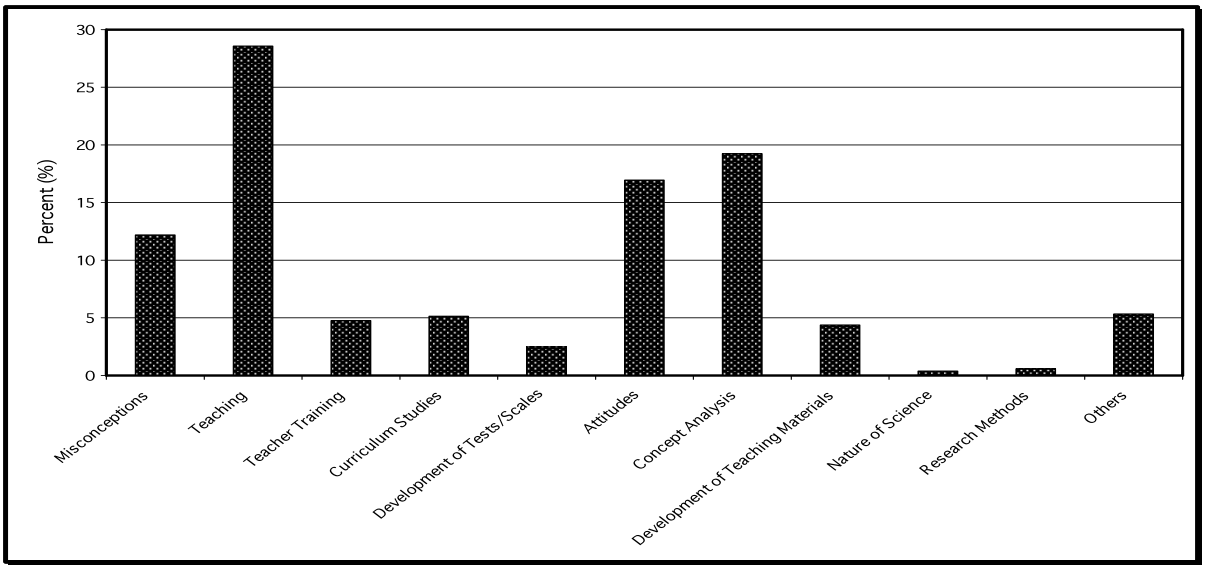

Figure 2. Frequently studied subject in science education researches

Concerning the how the trends in most frequently studied subjects are changing across the years, Figure 3 shows that there is an initial increase in the number of studies about identification of the misconceptions across various science concepts and it started to decrease. The area that concerning teaching about different areas of science is taking most of the attention and it is continuing to take the same attention across the years. Almost one third of the studies focus on this area. These studies mainly focus on development and application of new teaching approaches such as cooperative learning, problem or project-based learning, inquiry learning etc. Studies concerning science teacher training was about 10% at the beginning and decreased and then started to take attention in recent years. Another research area which is gradually decreasing is curriculum studies which were about 15% initially while it loses attention gradually and in recent years about 2% of the studies focused on curriculum. Figure 3 shows that the studies concerning students' attitudes and interest towards science and concept analyses are keeping their popularity across the years. Concept analyses studies are those describing and discussing important science concepts in terms of their meaning scientifically and how they should be taught without providing an experimental data in the light of the researchers' experiences. Although not included in Figure 3, the studies addressing development of teaching materials also started to gain acceleration in the recent years together with development or adaptation of tests/scales. This increase is understandable in terms of the increase in the number of papers focusing on the experimentation of new teaching approaches. These new approaches require development of new teaching materials and also new instruments to measure the effectiveness of these teaching methods.

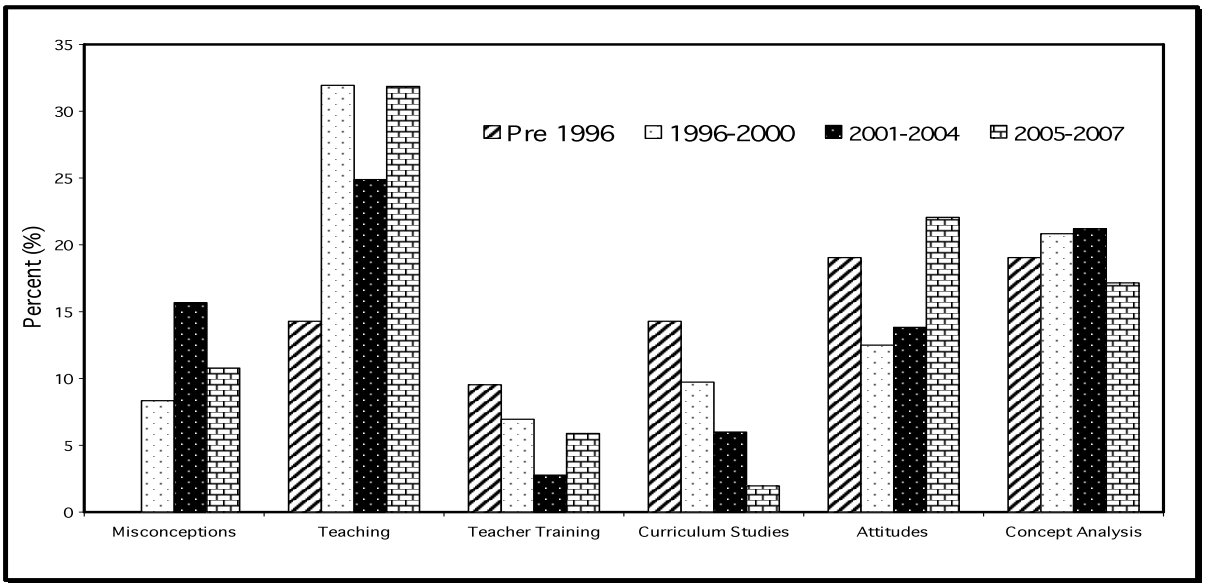

Figure 3. Trends in most frequently studied subjects in science education researches

Frequently Used Research Designs/Methods in Science Education Research

The research designs/methods used in the science research papers published in Turkey are given in Figure 4. As seen from Figure 4 in total almost two thirds of the researches published in science education are in quantitative and the rest are qualitative. There are researches using mixed approaches at about 3%. Regarding the research designs, non-experimental research design is dominating the half of the science education researches (49%). There are also experimental researches (17%) almost all of which are performed with quasi-experimental method. Concerning the qualitative research, it appears that there is almost no research in interactive design while one quarter of the all science education researches are composed of non-interactive design, mostly concept analysis method together with few historical analyses. It is also important to note that mixed method research designs are also emerging in Turkey with a total of 3%.

Concerning experimental research design, most of the researches are performed by quasi-experimental methods as expected. As science education researches are mainly performed by either teachers or in schools and schools have previously determined groups, the classes, the commonality of quasi-experimental method is understandable. The minority of true-experimental researches is also an expected result as it is common mostly in psychological researches but not in science education research. When non-experimental research design was investigated in detail it appears that descriptive (18%) and comparative (17%) are the most common methods together with survey (11%). There are a few studies using correlation method (4%). However, the ex-post facto and secondary data analysis methods are not introduced into the science education research in Turkey yet. Regarding qualitative research, interactive design is almost not evident in science education research papers except for case study method (3%). Other interactive qualitative research methods such as ethnography, phenomenology, grounded theory and critical studies are almost not known by Turkish science educators. Almost all of the studies categorized as qualitative are composed of concept analyses. Concept analyses studies are those describing and discussing the different meanings and appropriate use of the educational and scientific concepts such. These studies do not require the collection of experimental data and are mostly written on the

basis of the researchers' knowledge and experience. It is also common to use documents as data collection tools in this method.

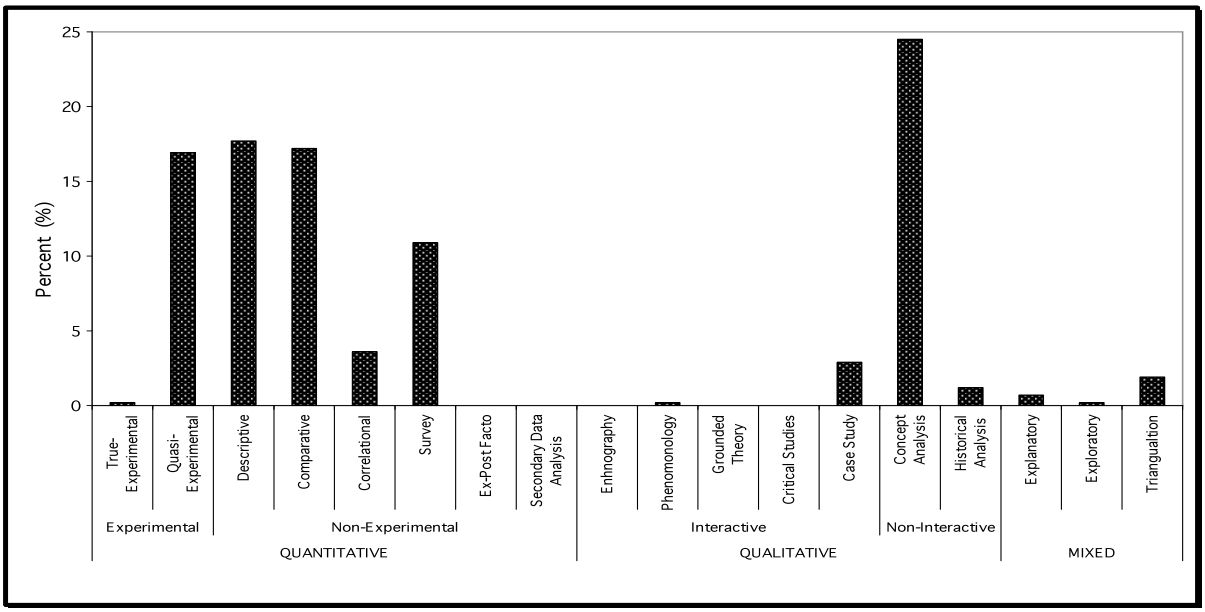

Figure 4. Frequently used research designs/methods in science education researches

Trends in the research approaches are shown in Figure 5. As seen from the figure there is no significant change in the trends in terms of research approach although at the beginning of 2000s quantitative researches slightly decrease and qualitative researches slightly increase. Turkish science education research community mostly prefer quantitative (two third) together with qualitative (one third) approaches compared to the international research in which the proportion of qualitative and mixed method researches are almost equal to the number of quantitative studies (Sozbilir, 2007). Mixed method research which is gaining an increasing attention in recent years (Johnson & Onwuegbuzie, 2004; Kelle, 2006; Sozbilir, 2007) is almost not evident in Turkey.

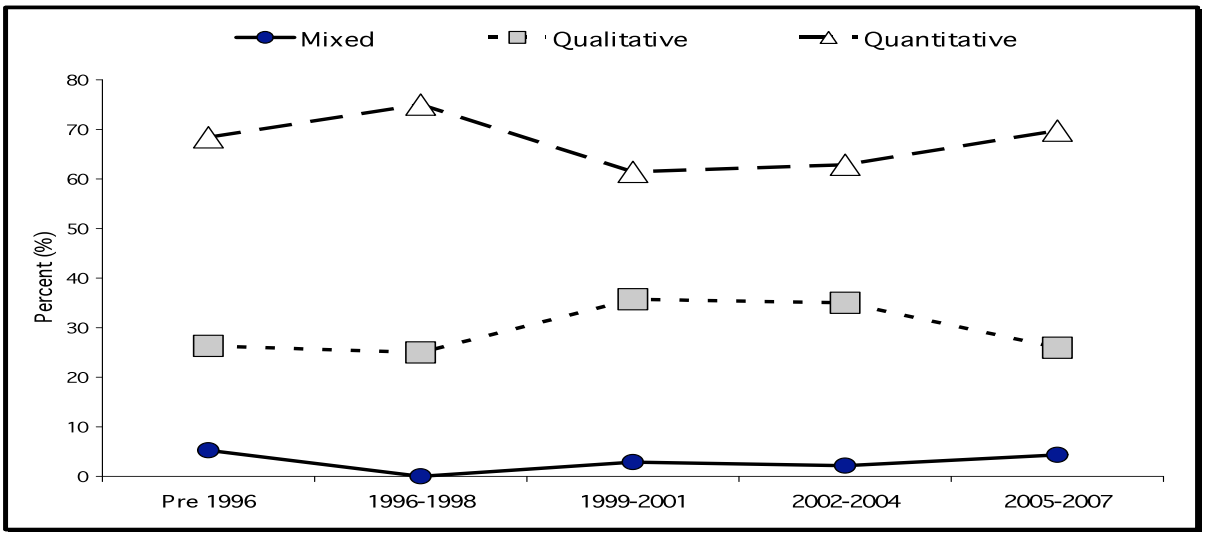

Figure 5. Trends in research methods used in science education researches

Frequently Used Data Collection Tools in Science Education Research

Data collection tools used in science education research papers published in Turkey are given in Table 2 and also Figures 6 and 7. In Table 2, total numbers of data collection tools are seen as more than the number of papers categorized. This is due to the use of more than one different data collection tool in one study.

Table 2. Frequently used data collection tools used in science education researhes

	Frequency	**%**
Observations	20	2,93
Interviews	69	10,11
Achievement Tests	224	32,84
Questionnaires	197	28,88
Documents	83	12,17
Alternative Scales (diagnostic tests, concept maps, portfolio, POE, etc)	10	1,46
Others	79	11,58
TOTAL	**682**	**100**

Table 2 indicates that the most common data collection tools used in science education research papers in Turkey are achievement tests (33%) and questionnaires (29%). Documents (12%) and interviews (10%) are also widely used. A small number of studies used observations (3%) for data collection purposes. When Figure 6 was investigated it appears that the open-ended and multiple choice type achievement tests are widely used. These tests are rather easy to prepare, administer and mark compared to the alternative tests such as two/three tier diagnostic tests, concept maps, POE (Predict-observe-explain) and portfolios and require less experience. Therefore, their uses are pretty common. The use of Likert type questionnaires are the most common one amongst the data collection tools as it is widely used throughout the world and Turkey is not an exception in this respect.

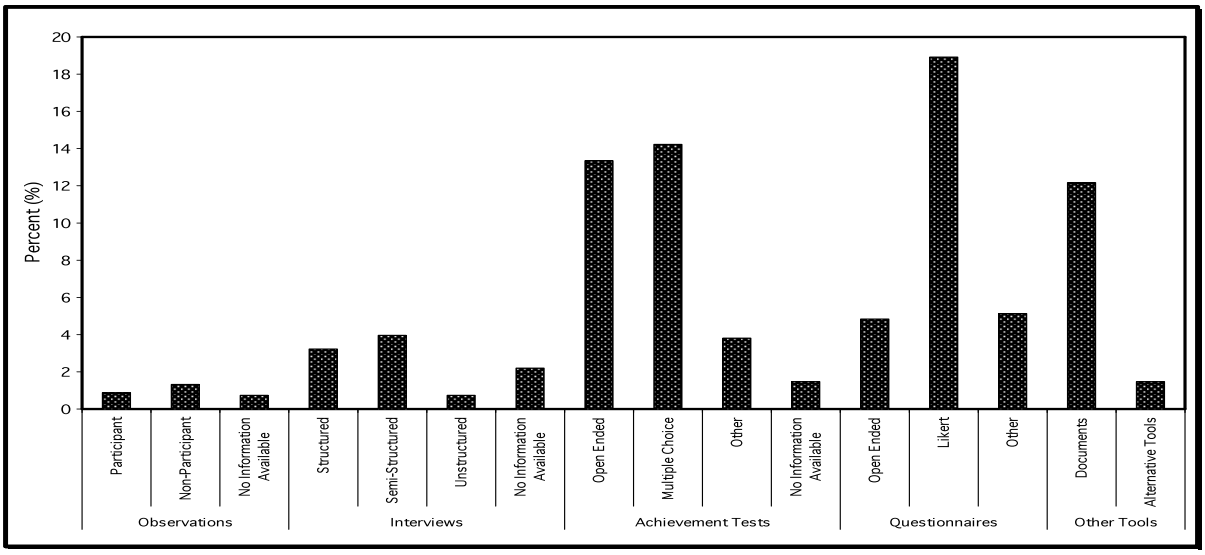

Figure 6. Frequently used data collection tools used in science education researches

Concerning the use of different data collection tools in a single study, Figure 7 shows that more than half of the studies rely on a single data collection tool and another 29% used only two different instruments. Only about 16% of the studies used either 3 or more data collection tools. This indicates that most of the science education research papers published in Turkey are weak in terms of data source variety and also have possible problems

associated with reliability. On the other hand, this case is also understandable as science education is a new research area and researchers in science education do not have required research knowledge and skills. Therefore, most of the researches are based on single-shot data collection approach.

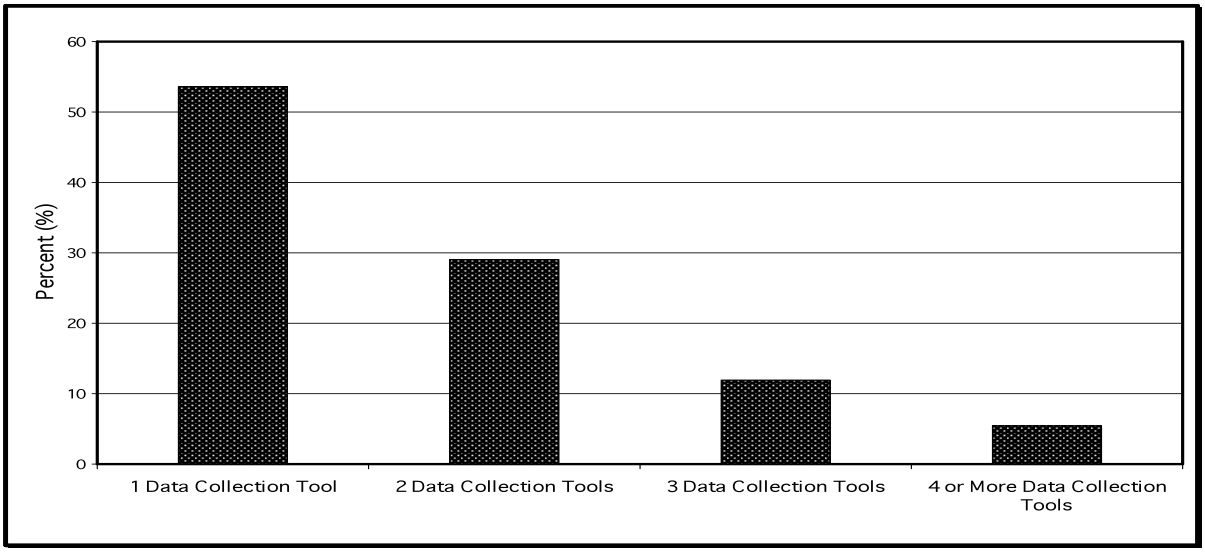

Figure 7. The number of different data collection tools reported in science education researches

Frequently Used Samples and Sample Sizes in Science Education Research

The following two graphs (Figures 8 and 9) show the frequently studied samples and sample sizes based on the data collection. Figure 7 indicates that most of data for the science education research are collected from undergraduate (33%) and secondary students (25%). There are also studies focusing on second level of elementary education (15%). Significant proportions (19%) of the samples are categorized as "Others". This result parallel with the research methods used.

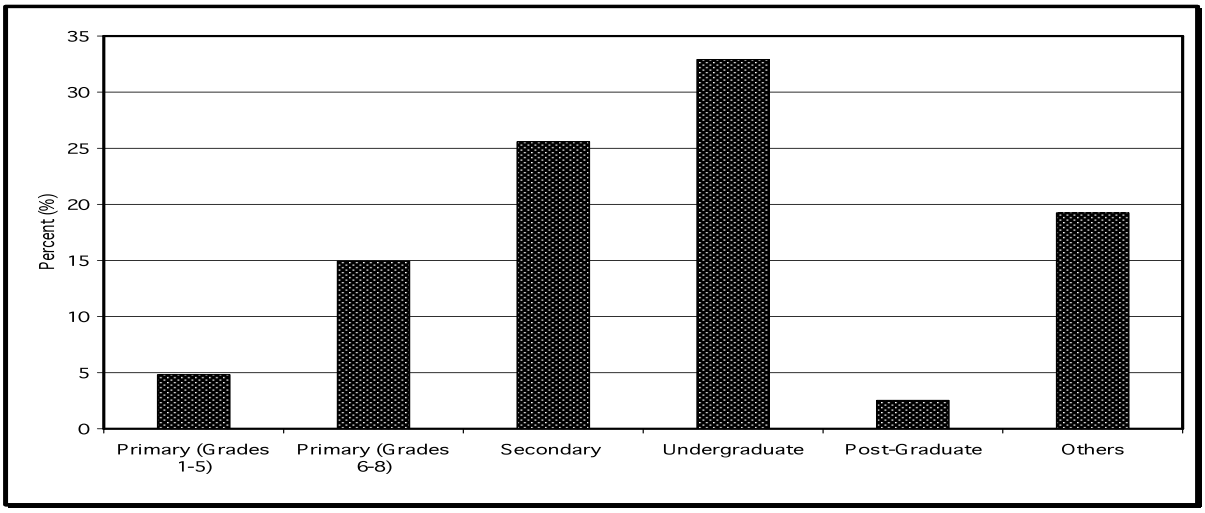

Figure 8. Frequently studied samples in science education researches

Regarding how the sample sizes are changed, Figure 9 indicates a parallel with the research methods. As non-experimental quantitative and non-interactive qualitative research designs were in common, the sample sizes are in good agreement with this finding. The most

commonly selected sample sizes were 51-100 participants (36%) and 101-200 participants (25%) and 201-500 participants (20%). Studying with these sample sizes are expected as the quasi-experimental studies are performed with mainly control and experimental groups and the class sizes in general vary from 25 to 40 at secondary level and 30-60 in undergraduate level in Turkey. Also as other non-experimental studies are also generally carried out in researchers' own classes or adjacent classes, these sample sizes are meaningful.

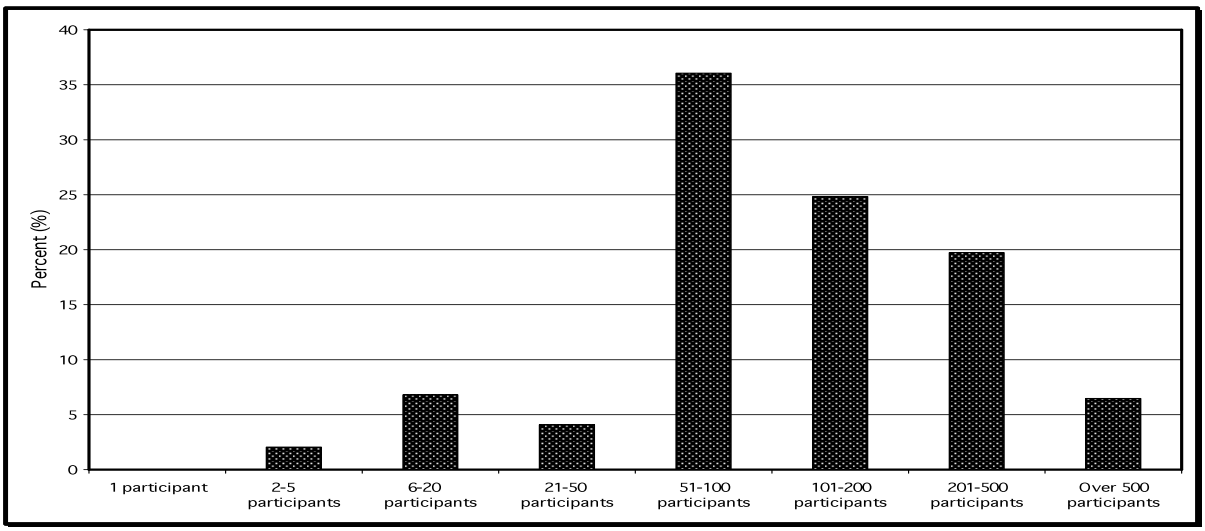

Figure 9. Frequently used sample sizes in science education researches

Frequently Used Data Analyses and Presentation Methods in Science Education Research

Various data analysis methods were used in science education researches (see Figure 10). As seen from the figure, more than half of the researches (52%) used descriptive data analyses methods and the results are presented as tables of frequencies, percentages, means and standard deviations in 44 % of the studies. Amongst the descriptive studies few studies (6%) used graphs to present the results. The 32% of the studies used inferential data analyses methods. Amongst the inferential methods the most common ones are t-test, ANOVA/ANCOVA and correlation with 16%, 10% and 4% respectively. There were only few samples of MANOVA/MANCOVA, regression, factor analysis, regression and non-parametric tests indicating. Regarding the qualitative data analysis descriptive data analysis (9%) together with the content analysis (6%) is widely used.

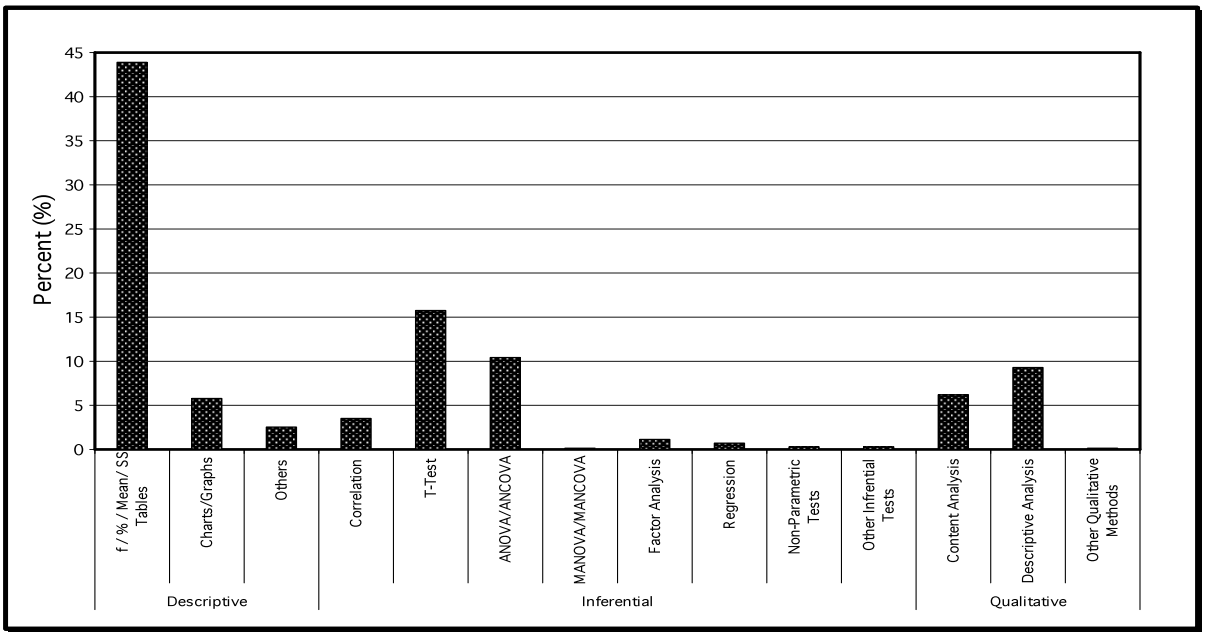

Figure 10. Frequently used data analysis methods used in science education researches

When the trends in data analyses methods are investigated it appears that descriptive methods showed an initial decrease and then an increase while inferential data analyses methods showed a reverse trend to descriptive methods. Regarding the qualitative data analyses methods there is no significant change over the years.

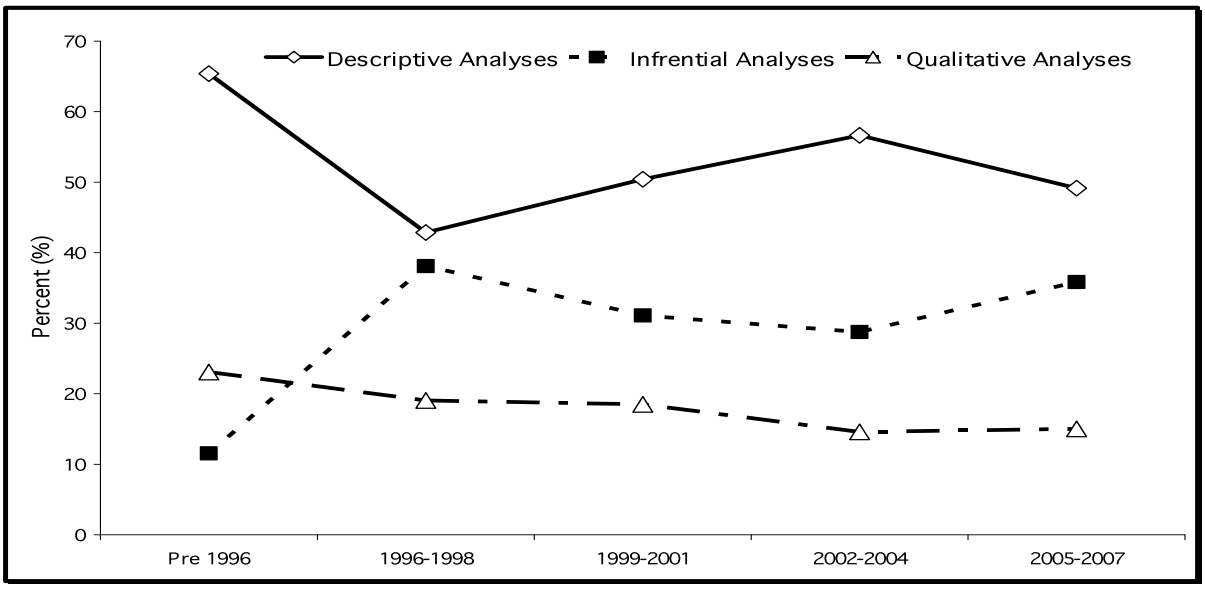

Figure 11. Trends in data analysis methods used in science education researches

Majority of the science education researches (43%) used only one data analysis method, while one third of the studies used two different data analysis methods. 21% of the studies used three different data analysis methods in one study. These studies also used multiple data collection tools.

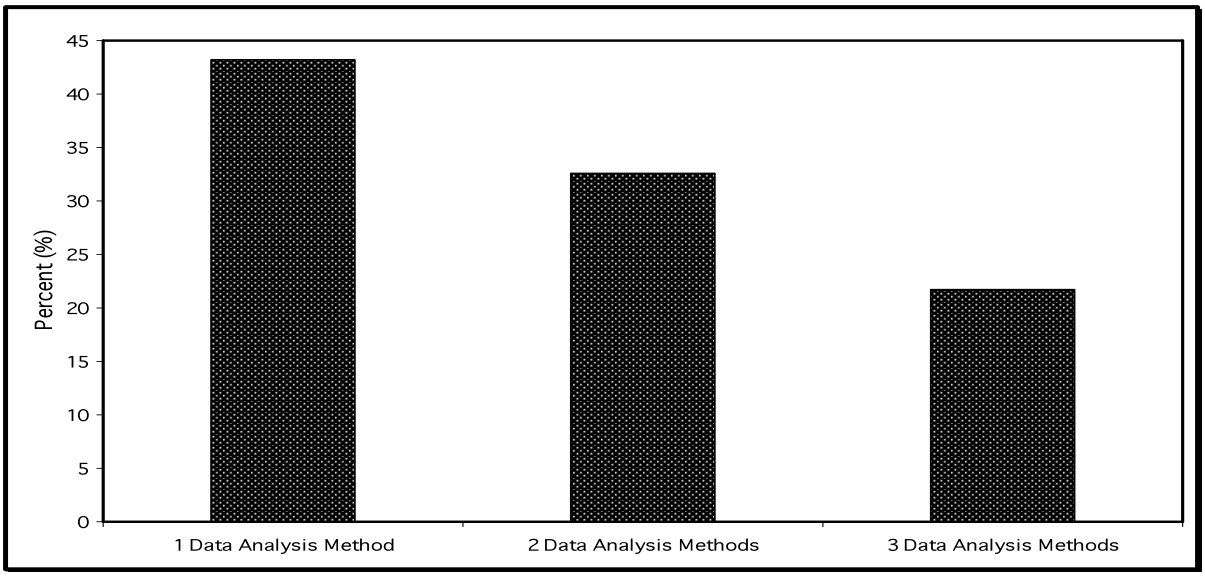

Figure 12. Numbers of data analysis methods used in science education researches

Discussions and Implications for Practice

As seen from Table 1 and Figure 1, it is over twenty years since the first science educations papers were published in educational journals in Turkey. Over the course of two decades, the number of people who have devoted their careers to doing research on the teaching and learning of science has increased significantly. There have also been significant developments in the subject matter studied and methodology for doing research in science education area and in the sophistication of the questions being investigated in the world. This paper aimed to determine the status and the trends of subject matters investigated and research methods/design and data analyses procedures used in science education research papers published in Turkey.

According to the results, 31 papers (out of 413) published in science education until 1999 were mostly descriptive and concept analysis. There is a significant increase in the number of science research papers published in Turkey from 1999 reaching a peak in year 2005. This significant change crosses with the re-structuring the schools of teacher education in terms of their functions and departmental structures by the YÖK (Güven, 2007; Tercanlıoğlu, 2004; Türkmen 2007). Before 1997 most of the academicians employed by schools of teacher education were performing research in disciplines such as chemistry, physics, biology or history instead of focusing research in teaching and learning of disciplines. After the re-structuring of the teacher training programs, the academic staff in schools of teacher education directed their attention towards carrying out more educational research than discipline based research. As the number of researches in science education increased so the number of journals publishing science education research. This re-structuring initially caused some inconveniences but in a couple of year's time many people chose to do educational research starting with the establishment of science education as a new research area in Turkey. This shift also brought together concerns about the quality of researches published as discussed below.

The studies focused on teaching (as an intervention), concept analysis, determining students' attitudes and interest towards science and identifying students' misconceptions about various scientific concepts are composed of three quarters of the total studies done by Turkish science education research community. These areas are also widely studied subjects

in the world (Sozbilir & Canpolat, 2006). In this sense, science education could be seen as keeping up with the international trends. However, shortage of the number of studies focusing on nature of science, research methods, teacher training, curriculum studies, integration of ICT into teaching, environmental education, socio-cultural issues in science, international studies, assessment in science education etc. indicates that there are problems with following the current trends in science education in the world. As seen from Figure 3, the percentage of subject matters frequently studied across years are fairly stable, except for teacher training and curriculum studies, indicating that science education researches are not keeping up adequately with the trends in the world. From this perspective it could be suggested that Turkish science education research community should closely follow the international trends. One way of many options could be including more courses at graduate level about international/comparative studies. Another option could be performing review studies such as this one and critical studies to follow closely the researches done inside and outside the Turkey and sharing the knowledge gained with the younger science educators. Perhaps the most important one is setting up national research priorities in science education and directing financial sources mostly on those studies. More importantly, we have to create our research interests reflecting our characteristics, virtues and needs as a society.

Concept analysis, quasi-experimental, descriptive, comparative studies and survey are frequently used research methods. Less frequently used research methods are correlational studies, case study, mixed methods. Qualitative methods (i.e. ethnography, phenomenology, grounded theory, critical studies) and some quantitative methods (i.e. ex-post facto and secondary data analysis) are either not known or not used by the science education researchers in Turkey. As seen from Figure 5, quantitative research designs are dominating science education and it is not showing a significant change over the years. In supporting the above findings most of the science education research papers were based on the data collected through achievement tests and questionnaires and also majority of the studies are based on data collected through one or two different data collection tool. These results suggest possible methodological weaknesses and lack of knowledge and skills in combining and using different research methods and integrating different data collection tools in order to strengthen the validity and reliability of the studies.

On the other hand, the lack of interactive qualitative research methods shows that Turkish science education research community is not well kept up with the international trends in research methods. There is a shift from quantitative to qualitative methods in the last two decades (Kelly & Lesh, 2000) and more recently to mixed methods by combining qualitative and quantitative methods (Johnson & Onwuegbuzie, 2004; Kelle, 2006; Sozbilir, 2007). However, the quality of the qualitative studies in the world is mixed because most students in education do not have enough knowledge and training in these methods (Hsu, 2005). In fact good qualitative studies are not easy to produce because, unlike quantitative studies with its established steps to follow, the unique situations of qualitative studies require judgment decisions that inexperienced researchers may not be able to make properly (Harry *et al*., 2005). Moreover, interpretation of qualitative results is especially challenging to new researchers. Therefore, in order to keep up with this methodological shift undoubtedly there is a need for urgent call to strengthen the instruction of qualitative-related methods at graduate level method course in Turkey.

As expected with the trends in educational research in the world (Hsu, 2005) science education research papers in Turkey included mainly descriptive and inferential statistics methods. Among those methods use of frequencies, percentages, means and standard

deviation tables, graphs together with t-test, ANOVA/ANCOVA were the most commons. There are some other data analysis procedures such as correlation, factor analysis, regression and non-parametric tests. Much of the qualitative data analysis methods were descriptive together with small percentage of content analysis. This is an expected result as most of the qualitative studies were composed of discussion of scientific concepts without an empirical data. From the methodological perspective, it could be suggested that using multiple methods and multiple data analysis procedures may help to increase the validity and reliability of studies resulting more high quality research papers.

As a result, to be good consumers of research, students should be able to understand and interpret concepts related to research methods/analyses frequently used science education researches. Thus it is highly recommended that method courses should constitute the basic cores of knowledge required for all graduate students in science education together with the subject knowledge itself.

It is hoped that this content analysis will provide some guidance for science educators, particularly new researchers, in making appropriate decisions and broadening their scopes when conducting research and writing academic publications in the future. It is also recommended that a similar study be repeated in future years; science education researchers can then monitor and review the research trends, and possibly find more international contribution to the field and some shifts of research trend.

It is also important to recognize that as asserted by White (1997) revolutions do not necessarily follow a linear course, nor do they go for ever. The trends picked out here and reported in other papers might not continue. New ones could emerge suddenly, or there could be a period of consolidation, or worse, stagnation or regression.

References

Ayas, A., Çepni, S. & Akdeniz, A.R. (1993). Development of the Turkish secondary science curriculum, *Science Education*, *77*(4), 433-440.

De Jong, O. (2007). Trends in western science curricula and science education research: a bird's eye view, *Journal of Baltic Science Education*, *6*(1), 15-22.

Elmore, P.B. & Woehlke, P.L. (1988). Statistical methods employed in American Educational Research Journal, Educational Researcher, and Review of Educational Research from 1978 to 1987, *Educational Researcher*, *17*(9), 19-20.

Elmore, P.B. & Woehlke, P.L. (1998). Twenty years of research methods employed in American Educational Research Journal, Educational Researcher, and Review of Educational Research. *Paper presented at the Annual Meeting of American Educational Research Association*, San Diego, CA, 13-17 April.

Grossman, G.M., Onkol, P.E. & Sands, M. (2006). Curriculum reform in Turkish teacher education: attitudes of teacher educators towards change in an EU candidate nation, *International Journal of Educational Development*, *27*, 138–150.

Harlen, W. & Simon, S. (2001). Elementary school science and the rise of primary science, *School Science Review*, *82*(300), 49-57.

Harry, B., Sturges, K.M. & Klinger, J.K. (2005). Mapping the process: an exemplar of process and challenge in grounded theory analysis, *Educational Researcher*, *34*(2), 3-13.

Hsu, T. (2005). Research methods and data analyses procedures used by educational researchers, *International Journal of Research & Method in Education, 28*(2), 109-133.

Jenkins, E.W. (2001). Friendship and debate: a century of promoting secondary school science, *School Science Review*, *82*(300), 19-30.

Johnson, R.B. & Onwuegbuzie, A.J. (2004). Mixed methods research: a research paradigm whose time has come, *Educational Researcher*, *33*(7), 14-26.

Keeves, J.P. (1998). *Methods and processes in research in science education*. In Fraser, B.J. & Tobin, K.G. (Eds) International Handbook of Science Education, Kluwer Academic Publishers, London, pp.1127-1153.

Kelle, U. (2006). Combining qualitative and quantitative methods in research practice: purposes and advantages, *Qualitative Research in Psychology, 3*, 293-311.

Kelly, A.E. & Lesh, R.A. (2000). Trends and shifts in research methods. In A.E. Kelly & R.A. Lesh (Eds) *Handbook of research design in mathematics and science education* Mahwah, NJ, Lawrence Erlbaum Associates, 35-44.

Kempa, R.F. (1991). *Research in Chemical Education: Past-Present and Future*. The 1991 Nyholm Memorial Lecture of the Royal Society of Chemistry.

Keselman, H.J., Huberty, C.J., Lix, L.M., Olejnik, S., Cribbie, L.A., Donauhe, B., Kowalchuk, R.A., Lowman, L.L., Petoskey, M.D., Keselman, J.C. & Lewin, J.R. (1998). Statistical practices of educational researchers: an analyses of their ANOVA, MANOVA, and ANCOVA analyses, *Review of Educational Research*, *68*(3), 350-386.

McMillan, J.H. & Schumacher, S. (2006). *Research in Education: Evidence-Based Inquiry* (Sixth Edition), Pearson, London.

Özden, M. (2007). Problems with science and technology education in Turkey, *Eurasia Journal of Mathematics, Science & Technology Education*, *3*(2), 157-161.

Rocard, M., Csermely, P., Jorde, D., Lenzen, D. Walberg-Henriksson, H., & Hemmo, V. (2007). *Science Education Now: A Renewed Pedagogy for the Future of Europe*. European Commission Report. Retrieved [12 May 2008] from http://ec.europa.eu/research/science-society/document_library/pdf_06/report-rocard-on-science-education_en.pdf.

Sozbilir, M. & Canpolat, N. (2006). *Fen eğitiminde son otuz yıldaki uluslar arası değişmeler: Dünyada çalışmalar nereye gidiyor? Türkiye bu çalışmaların neresinde? [Developments in science education in the last thirty years: Where the researches go in the world? Where about Turkey in these researches?]*. In Bahar, M. (Ed) Fen ve Teknoloji Öğretimi [Teaching Science and Technology], PegemA Publishers, Ankara, Turkey, pp.417-432.

Sozbilir, M. (2007). *Araştırma yaklaşımlarındaki paradigmatik dönüşümler ve bunların kimya eğitimi araştırmalarına yansımaları [Paradigmatic changes in the research methods and their reflections on chemistry education researches]*. Paper presented at the 1st National Chemistry Education Conference, 20-22 June, Istanbul.

Treagust, D.F. (2006). *International trends in science education research*. In Ramadas, J & Chunawala, S. (Eds) Research Trends in Science, Technology and Mathematics Education. Homi Bhabha Centre for Science Education, Tata Institute of Fundamental Research, Mumbai, India, pp. 125-146.

Türkmen, L. (1997). Science education developments in Turkey, *Science Education Around the World, 8*(4), 12-16.

Türkmen, L. (2007). The history of development of Turkish elementary teacher education and the place of science courses in the curriculum, *Eurasia Journal of Mathematics, Science & Technology Education, 3*(4), 327-341.

Wallace, J. & Louden, W. (1998). *Curriculum change in science: riding the waves of reform*. In Fraser, B.J. & Tobin, K.G. (Eds) International Handbook of Science Education, Kluwer Academic Publishers, London, pp.471-485.

White, R. (1997). Trends in research in science education, *Research in Science Education, 27*(2), 215-221.

Acknowledgement

The authors wish to acknowledge assistance received by four graduate students (Aysun Keskin, Gulden Nasuhbeyoglu, Murat Kiransan and Sakip Topal) in finding science education research papers from the journals and content analyzing of them.

Appendix 1. Title of the journals covered

Nr	Title of the Journal	Years Covered	Frequency *(%)*	
1	Abant Izzet Baysal Uni. Educ. Fac. Journal	2001-2005	13	*(3,1)*
2	Ahi Evran Uni. Kırşehir Educ. Fac. Journal	2005-2007	1	*(0,2)*
3	Anadolu Uni. Educ. Fac. Journal	2001-2005	1	*(0,2)*
4	Atatürk Uni. Kazım Karabekir Educ. Fac. Journal	2005-2007	1	*(0,2)*
5	Balıkesir Uni. Necatibey Educ. Fac. Electronic Journal of Sci & Math Educ.	2007-2008	3	*(0,7)*
6	Boğaziçi Uni. Educ. Fac. Journal	2002-2003	3	*(0,7)*
7	Çanakkale Onsekiz Mart Uni. Educ. Fac. Journal	2005-2008	1	*(0,2)*
8	Contemporary Education Journal	2000-2007	5	*(1,2)*
9	Çukurova Uni. Educ. Fac. Journal	2000-2005	7	*(1,7)*
10	Dokuz Eylül Uni. Buca Educ. Fac. Journal	1999-2006	40	*(9,7)*
11	Educational Sciences: Theory & Practice	2001-2007	9	*(2,2)*
12	EJMSTE (Eurasia Journal of Mathematics, Science and Technology Education)	2006-2007	1	*(0,2)*
13	Electronic Social Sciences Journal	2004-2007	4	*(1)*
14	Elementary Education Online	2003-2008	15	*(3,6)*
15	Erzincan Uni. Erzincan Educ. Fac. Journal	2002-2007	6	*(1,5)*
16	Gazi Uni. Gazi Educ. Fac. Journal	1999-2007	38	*(9,2)*
17	Gazi Uni. Turkish Educ. Sci. Journal	2003-2007	9	*(2,2)*
18	Hacettepe Uni. Educ. Fac. Journal	1987-2007	75	*(18,2)*
19	İnonü Uni. Educ. Fac. Journal	2002-2007	8	*(1,9)*
20	Journal of National Education	2000-2008	40	*(9,7)*
21	Kastamonu Uni. Kastamonu Educ. Fac. Journal	2002-2008	33	*(8)*
22	Marmara Uni. Atatürk Educ. Fac. Journal	1990-2005	32	*(7,7)*
23	Mehmet Akif Ersoy Uni. Burdur Educ. Fac. Journal	2005-2006	1	*(0,2)*
24	Ondokuz Mayıs Uni. Educ. Fac. Journal	2001-2007	14	*(3,4)*
25	Pamukkale Uni. Educ. Fac. Journal	1999-2007	23	*(5,5)*
26	Turkish Journal of Science Education	2004-2007	18	*(4,4)*
27	Uludağ University Educ. Fac. Journal	1988-2007	6	*(1,5)*
28	Yüzüncü Yıl Uni. Educ. Fac. Journal	2004-2007	6	*(1,5)*
		TOTAL	**413**	***(100)***

PAPER CLASSIFICATION FORM

Title of the Paper:

Authors:

Title of the Journal/Year/Volume/Issue/Pages:

SUBJECT OF THE PAPER

1.Misconceptions	( )	**5.**Development/Adaptation of Tests/Scales	( )	**9.**Nature of Science	( )
2.Teaching	( )	**6.**Attitudes	( )	**10.**Research Methods	( )
3.Teacher Training	( )	**7.**Concept Analysis	( )	**11.**Others	( )
4.Curriculum Studies	( )	**8.**Development of Teaching Materials	( )		

RESEARCH DESING / METHODS OF THE PAPER

1. QUANTITATIVE				2. QUALITATIVE				3. MIXED	
1.Experimental		**2.Non-Experimental**		**3.Interactive**		**4.Non-Interactive**		**5.Mixed**	
11. True Experimen.	( )	**21.** Descriptive Longitudinal ♦ Cross-age ♦	( )	**31.** Ethnograph	( )	**41.** Concept Analysis	( )	**51.** Explanatory (Quan \ Qual	( )
12. Quasi Experimen.	( )	**22.**Comparative	( )	**32.** Phenomeno-logy	( )	**42.** Historical Analysis	( )	**52.** Exploratory (Qual \ Quan)	( )
13. Single Subject	( )	**23.**Correlational	( )	**33.** Grounded Theory	( )	**43.** Others	( )	**53.**Triangulation (Quan + Qual)	( )
		24. Survey	( )	**34.** Critical Stud.	( )				
		25. Ex-Post Facto	( )	**35.** Case Study	( )				
		26. Secondary Data Analysis	( )	**36.** Other	( )				

DATA COLLECTION TOOLS

1. Observation ..... ( )
Participant ♦ Non-Participant ♦

2. Interview ..... ( )
Struct.♦ Semi-Struct.♦ Un-Struct.♦ Other ♦

3. Achievement Tests ..... ( )
Open-Ended ♦ Multiple Choices ♦ Other ♦

4. Questionnaire ..... ( )
Open-Ended ♦ Likert ♦ Other ♦

5. Documents ..... ( )

6. Alternative Instruments (diagnostic tests, Concept Maps, P-O-E, portfolio etc.) ..... ( )

7. Others (please write name) ..... ( )

SAMPLE

Sample:	**Sample Size:**
1. Elementary (1-5) ( )	.....
2. Elementary (6-8) ( )	.....
3. Secondary ..... ( )	.....
4. Undergraduate ... ( )	.....
5. Post-Graduate ... ( )	.....
6. Others ..... ( )	.....

DATA ANALYSIS METHODS

QUANTITATIVE DATA ANALYSIS				QUALITATIVE DATA ANALYSIS	
1. Descriptive		**2. Inferential**		**3. Qualitative**	
11. Frequency/%/MEAN/SD Tables	( )	**21.** Correlation	( )	**31.** Content Analysis	( )
12. Graphs	( )	**22.** t-test	( )	**32.** Descriptive Analysis	( )
13. Other	( )	**23.** ANOVA/ANCOVA	( )	**33.** Other	( )
		24. MANOVA/MANCOVA	( )		
		25. Factor Analysis	( )		
		26. Regression	( )		
		27. Non-Parametric Tests	( )		
		28. Other	( )		

Please use here if you need to give extra information:

© Dr. Mustafa SOZBILIR – sozbilir@atauni.edu.tr Atatürk Univ. KK Educ. Fac. Dept. Sec. Sci. & Math. Educ. 25240 ERZURUM/TURKEY